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A STUDY TO DETERMINE

THE MINIMUM MANPOWER REQUIREMENTS TO SUPPORT AN AUTOMATED MATERIAL DISTRIBUTION SYSTEM AT THE NAVAL HOSPITAL SAN DIEGO

A Graduate Research Project

Submitted to the Faculty of

Baylor University

In Partial Fulfillment of the

Requirements for the Degree

of

Master of Health Care Administration

by

Lieutenant James F. Jahnke, MSC, USN

July 1988

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There are several individuals who contributed their time, their expertise, and their patience toward this project and to whom I would like to express my appreciation.

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Secondly, I am grateful for the assistance provided by the San Diego Detachment of the Navy Manpower Engineering Command (recently disestablished), and the Officer in Charge, Mr. Dick Ruiz, who allowed members of his staff to take time during the work day to assist me. Specifically, Ms. Audrey Clements, who has been my consultant from the project's inception to its final proof; and, Mr. M. Dwayne Cheeks, Mr. John Carter and Mr. Mel Robinson, all of whom walked miles of hallways with me while gathering the necessary data for this project.

Thirdly, I want to recognize Mr. Mike Cono of the University of California, San Diego Medical Center, who spent an entire Saturday showing me the 'statistical' error of my ways.

Finally, I would like to thank CAPT D. Benander, MSC, USN - my preceptor and my friend. His [illegible]or when discussing issues coupled with his willingness to listen made this a truly enjoyable learning experience.

To each of you, it is my sincere hope this project justly reflects your contributions and support.

LIST OF ILLUSTRATIONS

I. INTRODUCTION

According to the American Hospital Association's 1987 edition of Hospital Statistics, labor accounted for over 55% of the total costs reported by American hospitals in 1986. Efforts by hospital chief executive officers to reduce this percentage through the elimination of positions or the combination of tasks are an ongoing endeavor. Efficient staff utilization is an additional concern; that is, ensuring that professional clinical personnel are not spending their time doing tasks outside of their profession. "Nurses should not conduct [supply] inventories or transport supplies" (Koprowski 28). When this blurring of clinical occupations and administrative tasks occurs, the assignment of actual costs to the performance of assigned duties is nearly impossible.

Federal healthcare facilities are concerned with labor costs as well, and the Naval Hospital San Diego is no exception. When the new replacement facility was dedicated January 23, 1988, the Naval Hospital San Diego consolidated nearly forty individual buildings into a modern complex of 1.2 million square feet. This includes a 560 bed, five story acute care nursing tower, 290,000 square feet of outpatient clinics, and an ancillary services complex running the length of three football fields. To achieve improved staff efficiency in such a huge, complex facility, robotic technology has been incorporated in its design, to an extent never before seen in a United States Military Treatment Facility.

Conditions which Prompted the Study

Naval Hospital San Diego has awarded a contract to the American Sterilizer Company (AMSCO) for a materials handling system that employs electronically guided vehicles to carry carts containing supplies, food trays, linens and other materials to and from the wards and the ambulatory care clinics. The primary objective of this distribution system is: "(The) Release of skilled personnel from distribution providing more time for clinical care of patients (and) More effective use of unskilled personnel through reduction of the labor required for distribution" (Material Distribution Report 7). In addition, the AMSCO system is intended to improve the quality control of material handling, substantially augment infection control efforts through the utilization of enclosed carts and dedicated hallways/elevators and to maximize material distribution efficiency.

These Automated Guided Vehicles (Figure 1) proceed from a central dispatch area (Figure 2) which is controlled by trained technicians. From this central dispatch area, the programmed Automated Guided Vehicles proceed along dedicated corridors and elevators to material handling rooms located on each floor of the three main buildings of the complex. Depending upon the commodity being transported, the Automated Guided Vehicles carry general purpose carts, interphase carts upon which C-lockers hang, or food carts. The general purpose cart generally would be empty, to be filled on the floor with trash or dirty linen. The

C-lockers would contain medical material or linen, while the food carts contain the patient meals. Upon their arrival, the carts are automatically deposited at designated discharge points.

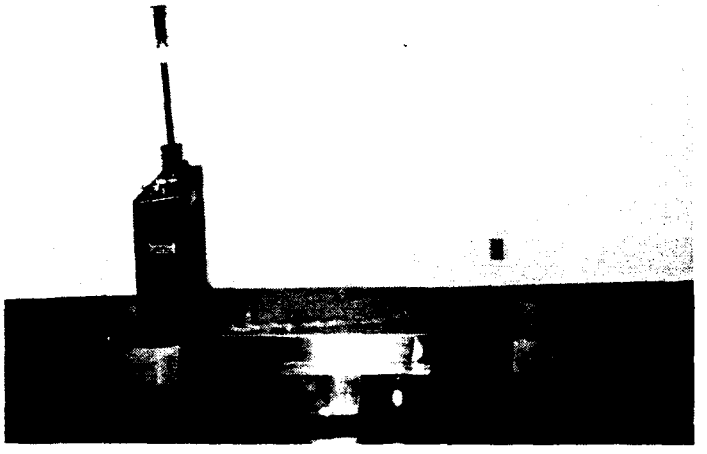
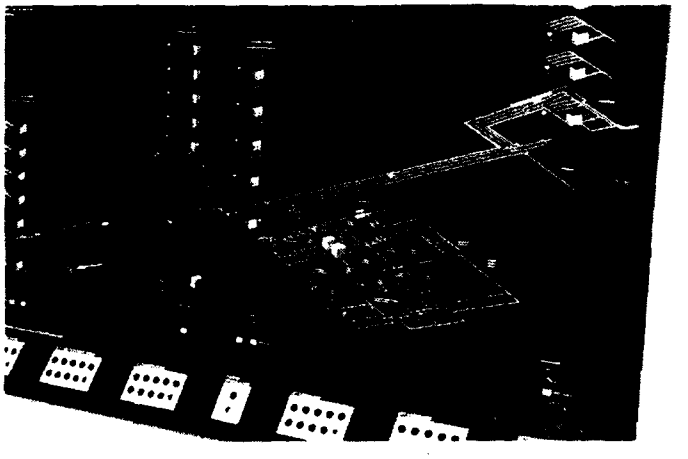


Figure 1. Automated Guided Vehicle.

Figure 2. Master Monitor Panel.

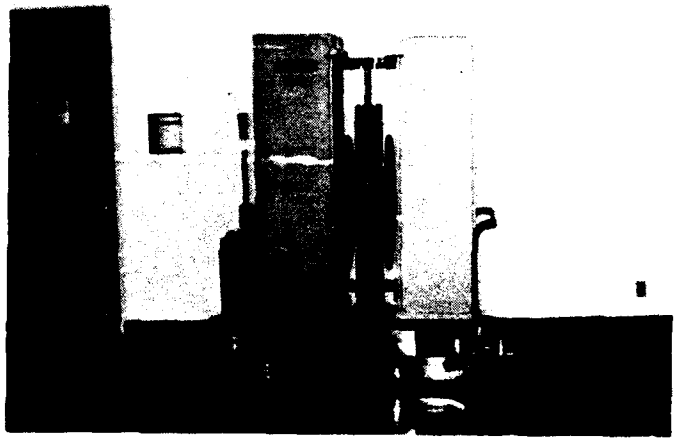


The Automated Guided Vehicle then proceeds to the sending spur to pickup a general purpose cart with trash or dirty linen, an interphase cart with C-lockers requiring replenishment, or a

food cart with dirty trays (Figure 3). The preprogrammed Automated Guided Vehicle then proceeds to carry the cart from the area to the appropriate destination, either back to dispatch, to the loading docks or to decontamination (Figure 4).

Figure 3. Interphase carts loaded with C-lockers. Please note the sending spur upon which cart's wheels must be precisely located.

Figure 4. Automated Guided Vehicle loaded with an interphase cart with two C-lockers.



Normally, "new and improved" methods of performing an operation are assumed to result in decreased costs; in this case,

one would assume a decline in labor costs. However, the fundamental principles of cost analysis apply:

> First, a cost savings results when the monies that would normally be spent are reduced. Secondly, a cost avoidance results when available, underutilized resources are used instead of new or additional resources acquired. And third...a savings in labor costs occurs only when a position is eliminated from a budget. Improved efficiency resulting from a technological change without a budget reduction is not a savings (Sanderson 45).

The first statement of the primary objective of this distribution system addresses personnel utilization. Closer examination reveals labor cost savings will not be achieved through the implementation of this system, for as Sanderson states, improving the efficiency of the hospital's professional staff without a concomitant budget decrease does not result in cost savings. A review of the FY88 and FY89 budget submission for material handling does not reveal such a budget decrease.

The latter statement of the primary objective assumes a practice of using unskilled labor to distribute hospital material. The former practice at the Naval Hospital San Diego was what is referred to as the "fetch and carry method" (Housley 175). It involved the submission of supply requisitions and the conveyance of the needed supplies by professional and paraprofessional nursing staff assigned to the wards and outpatient areas. Budgetary restraints have always precluded the hiring of orderlies to perform these tasks for them.

Additionally, the former Naval Hospital San Diego was spread out among 77 buildings. The sprawling nature of that facility required material handling to be accomplished via various levels of interior hallways, exterior walkways, sidewalks, and streets, and in competition with pedestrian and vehicular traffic.

The implementation of this new material distribution system is therefore not going to result in a reduction of labor costs, but in reality, an increase in labor requirements. This is due to the fact that personnel are needed to position/remove the carts at the pickup and discharge points of the Automated Guided Vehicle, a previously unnecessary requirement. With this in mind, the question is obvious; **How many people will this AMSCO delivery system require?**

Although the contracted automated delivery system is unique within the United States Navy Medical Department, less sophisticated models of the AMSCO system have been in place at several facilities for a number of years. When contacted by those responsible for the planning of the installation of this system at Naval Hospital San Diego, they willingly shared their experiences regarding the AMSCO system.

One of these facilities is the Veterans Administration Medical Center (VAMC) at Bay Pines, Florida. According to Mr. Philip Ganci, the Assistant Chief of the Supply, Processing and Distribution Section, the VAMC has been able to reassign one-third of the supply technicians that had initially been hired to support the automated delivery system (personal interview 07

Oct 1987). This reassignment could only be accomplished after a historical record had been developed and analyzed by the managers of the supply distribution system. If manpower requirements could have been accurately determined prior to the installation of the system, it conceivably could have resulted in a significant cost avoidance by not hiring the 'extra' supply technicians at the outset.

The insight gleaned from the experiences of other facilities has generally been incorporated into the Naval Hospital San Diego's plan for the implementation of this automated material delivery system. However, no attempt has been made to quantitatively assess the manpower requirements for this system, even though overhiring has occurred in other facilities. When budgeting for personnel, those responsible for the planning of this system determined that 28 "logistical technicians" would be required. The justification for these additional requirements was: "(To) cover 14 remote Material Handling Rooms 18 hours a day, 7 days a week" (Addendum to FY88 budget submission dated 10 August 1987). At the Civil Service grade proposed to fill these positions, the annual salary and benefits totaled $578,515.00 (Civilian Personnel, New Facility Requirements dated 03 August 1987). Each position eliminated through reassessment would result in a cost avoidance of $20,661.25 per annum.

Problem Statement

The purpose of the study was to determine the minimum manpower requirements for the American Sterilizer Company automated material distribution system at the new Naval Hospital San Diego.

Objectives

The objectives necessary to complete this project were:

1. To identify each task that must be performed by an individual at each discharge and pickup point specific for the material being delivered.
2. To identify each element of the particular task that must be performed by that individual.
3. To assign motion times to each of these task elements.
4. To derive the total amount of time required to accomplish each task from the aggregate of the elemental motion times.
5. To integrate these task times with the delivery requirements of the wards and outpatient areas for each type of material being handled.
6. To develop a microcomputer model that would demonstrate the potential efficiency of the distribution system

given the predetermined time for accomplishing each task and the prerequisites of the ward and clinic areas.

7. To demonstrate to the Commanding Officer the applicability of the study for determining the manpower requirements for the automated material delivery system.

Criteria

1. Data gathering techniques, analysis of that data, and conclusions resulting from that analysis must be consistent with established methods engineering standards as used by the Department of the Navy's Manpower Engineering Command.
2. The microcomputer model developed must provide the flexibility to allow for changes in the delivery schedule for the ward and clinic areas.

Assumptions

The executives of the Naval Hospital San Diego must concur with and support the primary objective of the AMSCO material distribution system; that is, to remove professional and paraprofessional clinical personnel from nonprofessional duties, thus achieving more efficient personnel utilization.

Limitations

The material needs of the hospital wards and the outpatient clinic areas must be met to ensure the continued delivery of quality patient care, even if this results in the employment of a greater number of personnel than determined to be required through this study.

II METHODOLOGY

Predetermined Time Systems - Background

Motion and Time Study "refers to a broad branch of knowledge dealing with the systematic determination of preferable work methods, with the appraisal, in terms of time, of the value of work involving human activity, and with the development of material required to make practical use of these data" (Mundel 2). Two broad categories within this branch of knowledge are methods study and work measurement. It is the latter which is applicable to this study, for the objective is to determine manpower requirements for tasks that were not previously being performed at the Naval Hospital San Diego.

Work measurement is the appraisal of work in terms of time, thus creating a time standard for the performance of that work. Frederick Taylor is generally referred to as the father of modern time study in the United States (Neibel 10) for his work at the

Midvale Steel Company in 1881 (Metzger 158). In principle, little has changed in time study since its inception; however, the terminology has changed over the years as has its depth (Jay 2). From the days of Taylor's basic stopwatch studies, industry has progressively embraced the research, analysis and development of standard time. "The standard time for a given operation is the time required for an average operator, fully qualified and trained and working at a normal pace, to perform the operation. It is determined by summarizing the allowed time for all of the individual elements comprised by the time study" (Neibel 393).

To be valid, standard time requires a statistically derived number of timed observations be made for each element of the task which is being studied. This time study is a lengthy and an expensive procedure. Depending upon the accuracy desired, it requires trained observers at the worksite or the review of micromotion films of numerous cycles of the task being studied. As an alternative, and for consistency between different analysts, standard time data in the form of charts, curves, and tables are frequently used. Standard time data "are elemental time standards taken from time studies that have been proved to be satisfactory" (Niebel 403). These standards are classified and filed to permit the analyst to refer to them and measure a specific job without the necessity of using a timing device. "When properly applied, standard data permit the establishment of accurate time standards in advance of the time that the job is to be performed" (428).

Predetermined time standards have become increasingly important to industrial companies and financial establishments in setting time standards for various work tasks (Maynard 5-4). Predetermined time systems employ first-order work-unit performance time data which may be resynthesized into a standard time for a job, even when the job is different from what was previously measured (Mundel 395). In other words, it assigns basic times for the basic motions. A basic motion is defined as "Any motion which starts from rest, moves through space and ends at rest" (Maynard 5-8). For example, hand activity is divided into three classifications: reach, move, and turn. Additional allowances of distance, control, precision, force and change of position are applied to the classification of reach and move. Control is further subclassified into five classes, and so on, until an accurate time representation of the task element can be quantifiably obtained. Several types of predetermined time systems have developed over the years; the work accomplished by H.B. Maynard is most notable in this field.

As explained by Mundel, a predetermined time system offers several advantages. It offers the opportunity to estimate the time for the performance of a task before it is performed and it does away with the necessity of rating each individual study. It allows for an alternative approach to setting standard times without intensive time study or work sampling. When used with repetitive work, a predetermined time system allows for an estimate of staff resources, equipment, and space requirements

prior to actual implementation of the process (398-9). An important feature of a predetermined time system is its incorporation of allowances into its Time Measurement Unit (TMU). Such allowance factors include: fatigue, unavoidable delays, and personal needs, and when appropriate, learning time, setup time, and time due to irregular or unusual operations (Neibel 373).

Methods Time Measurement - Application Procedure

There are various types of Predetermined Time Systems, most of which are public domain, although several are proprietary. In this project, the Methods Time Measurement application procedure was initially used to envision the automated material delivery that was not yet existent. It provided the author with a logical step by step process with which to assess the operation under study.

Step 1 - The Basic Method

Thorough site visits and interviews were used to "establish the basic method," a broad description of the purpose of the operation and the general details (Maynard 5-51). For the operation under study, therefore, the basic method is:

1) Material (supplies, linen, empty trash/soiled linen containers) are positioned onto the sending spur at dispatch for pickup by the Automated Guided Vehicle.

2) The Automated Guided Vehicle picks up the load and proceeds to the Material Handling Room to which that load has been programmed.

3) The Automated Guided Vehicle discharges the load at the drop off point and then returns to dispatch or picks up the load awaiting it on the sending spur within the Material Handling Room.

4) The Logistic Technician transports the material from the Material Handling Room to the ultimate destination via the interphase carts or general purpose carts.

5) The Logistic Technician transfers the restocked C-lockers containing linen or supplies from the interphase cart onto special railings on the wall; or,

6) The Logistic Technician transfers the empty trash/soiled linen general purpose carts into the room in which it is stored.

7) The Logistic Technician transfers the C-lockers requiring restocking from the wall railings onto the interphase cart.

8) The Logistic Technician transfers the C-lockers requiring restocking from the ultimate destination to the Material Handling Room; or,

9) The Logistic Technician transfers the full trash/soiled linen general purpose cart back to the Material Handling Room.

10) The Logistic Technician positions the returning load onto the sending spur within the Material Handling Room and programs the returning load's destination (via the Automated Guided Vehicle).

Step 2 - Organized Information

Once the basic method was determined, information germane to the material distribution operation had to be gathered. This information included:

Material storage rooms - The locations of all Soiled Utility Rooms, Clean Storage Rooms, Clean Linen Rooms, etc. had to be determined. This was accomplished through a computer printout, which listed each of these rooms by room number, room title, and Department title. These rooms were functionally designated by the architect, and were located on the original architectural drawings. However, there are innumerable changes in any construction project of this size and consequently, some of the rooms designated on the original drawings did not appear on the "as-built" blueprints.

Distances - Once the locations of the rooms designated to receive the materials were known, the author measured the distance the Logistic Technician would be required to travel for each delivery. This distance would be a constant, measured from

the nearest of the Material Handling Rooms (where the Automated Guided Vehicle would drop off the supplies) to the ultimate destination (the store room within the clinic or ward.) Rather than estimating this distance from the architectural blueprints, a hand held measuring wheel was used. Standard techniques were employed to ensure accurate results; for example, the same individual used the same measuring wheel, measurements were taken uniformly, and the wheel was walked down the center of each hallway. The actual distance to be travelled by the Logistic Technician in the accomplishment of his or her assignment was necessary for calculating and assigning the standard Time Measured Units (TMUs).

Equipment - The equipment that was to be used to transport the medical material to the ultimate destination had to be identified as well as the auxiliary devices that were involved in the operation. Some of this equipment was unique to this system and to this facility, so it was not available to the author at the start of this project. In fact, the cart to be used for the transport of soiled linen and trash is still in the manufacture stage, and has yet to be accepted by the Naval Hospital San Diego. The equipment that has been identified and is involved in the movement of material from the material handling rooms to the ultimate destinations are described below.

Interphase Cart: a large, bulky, four wheeled platform designed high enough off of the ground to allow for the Automated Guided Vehicle to go under it during the transportation phase of the operation. Two large, hand-operated, wheels raise and lower the hooks upon which the C-lockers hang. These hooks are attached on top of a spindle that allows the two hanging C-lockers to be turned as a unit for accessibility to the Logistic Technician. A handle is on one end of the interphase cart, allowing it to be pushed by the Logistic Technician. This cart provides the means by which the C-lockers containing the medical materials are transported to the ultimate destination. Figure 5.

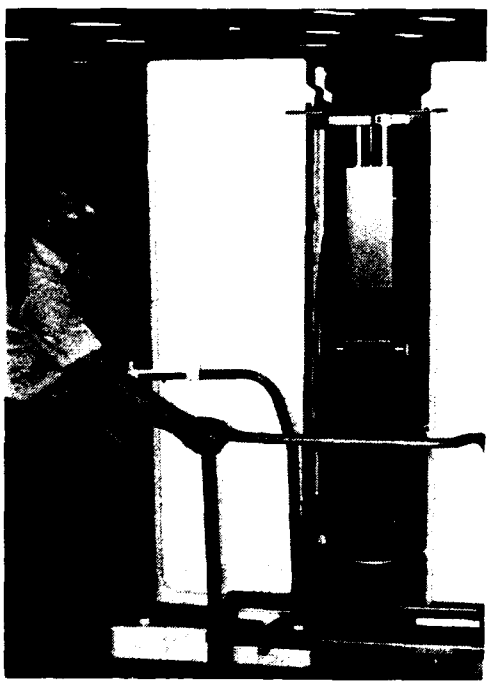
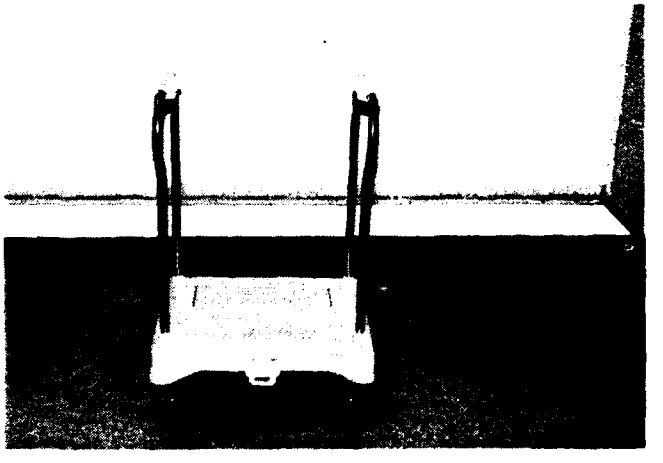


Figure 5. Interphase Cart. Note the C-locker being loaded by the Logistic Technician using a TR-3.

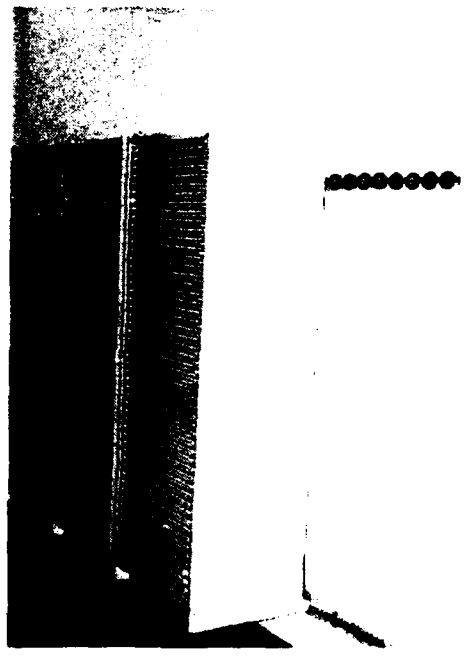
TR-3 Cart: a small, four wheeled platform cart, with a foot pedal and two levers which are controlled by the foot pedal. Figure 5. The TR-3 cart is pushed under the C-locker which is hanging on the walls via a special railing. When the pedal is depressed, the levers raise up out of the platform, lifting the C-locker off of the rail. As the foot pedal is slowly raised, the levers lower into the platform, allowing the C-locker to settle on the platform. To hang the C-lockers, the TR-3 with the C-locker on the platform is positioned in front of the rail. The foot pedal is then depressed, raising the C-locker onto the rail. Although each individual TR-3 cart can transport only one C-locker at a time, the TR-3s can be hooked together like a train and used to transport several C-lockers at one time.

Figure 6. TR-3 cart. The pedal which raises and lowers the two levers in the platform of the cart is in front, centered.



C-Lockers: are so named by their catalogue nomenclature. These lockers are five feet tall, three feet wide, and four feet deep. They offer a wide range of interior shelf heights, making it ideal for medical material storage, which can range from intravenous solutions in two liter bottles to boxes of bandages. The door is a 'roll-top' type, running from the bottom to the top where it can be secured. Security is afforded via locks which prevent the door from being dropped down, but, since it is made of plastic, security can be compromised. In the rear of the locker, toward the top, there is an extended lip, which allows the locker to be hung from the wall railing (Figure 7).

Figure 7. C-lockers. Note the railing and roll-top door.



Material Handling Room - where the Automated Guided Vehicle drops off the interphase cart with the replenished C-lockers, or the empty general purpose cart, and picks up the interphase cart with the C-lockers to be restocked or the general purpose cart filled with soiled linen or trash. This room contains the elevators used solely by the Automated Guided Vehicles. A wire guide path guides the Automated Guided Vehicle from the elevator to the specific drop off point and sending spur. The sending spur is identified by two pads, which are depressed when the wheels of the cart are properly positioned upon them. These pads correspond to a control panel, by which the Logistic Technician programs the Automated Guided Vehicle to proceed to the proper destination.

Step 3 - Detailed Elemental Breakdown and Analysis

The Predetermined Time System used for achieving the objective of this study was the Defense Work Measurement Standard Time Data Program, contained within the Department of Defense (DoD) Directive 5010.15.1-M. This Directive is published in a series of volumes, providing standard time data for various occupations classified by the Department of Labor. The selection of this system and its applicability to the project at hand was determined through on-site visits and interviews with the project manager responsible for the implementation of the automated material delivery system into the hospital.

A member of the Material Management staff was observed as he maneuvered the interphase cart, exchanged the C-lockers, and then repositioned the interphase cart for pickup by the Automated Guided Vehicle. Appendix A is a table describing the elemental breakdown of this operation when the interphase cart is carrying two C-lockers. Column 1 describes each element in the vernacular, while Column 2 presents a more succinct description. Column 3 assigns the standard Time Measured Units (TMUs) for the element. Column 4 identifies the source from which these assigned TMUs were obtained. Columns 5 is self-explanatory and Column 6 provides the total TMUs for each element. Similarly, Appendix B provides an elemental breakdown for when the interphase cart is transporting only one C-locker.

The variable element in this operation is the distance (in feet) between the Material Handling Room and the ultimate destinations. All of the other elements are constant, regardless of where within the hospital the operation takes place.

III DISCUSSION

The Goal

A literature search regarding the utilization of a predetermined time system for the assignment of standard time measured units for a material handling system within a health care facility was fruitless. The use of a predetermined time

system, however, was the keystone upon which the objective of this study was based. Therefore, it was necessary to demonstrate the applicability and appropriateness of the Defense Work Measurement Standard Time Data Program (the chosen predetermined time system) to this particular setting. To do this, a paired comparisons test between the estimated times determined through the utilization of the selected predetermined time system and the actual times observed through stop watch studies was conducted for seventy one deliveries of medical materials.

The Method

Actual stopwatch time measurement studies were taken of deliveries made using the basic method. This latter point is significant, because all predetermined time systems assume standard methodologies for accomplishing the operation. Therefore, in those cases whereby individuals had made modifications to the delivery techniques, the estimated and actual delivery times were excluded. An example of such a modification was noted in the Orthopedics Department. The Department Head refused to allow periodic deliveries throughout the day, even though this was the designed method for delivering medical material. Therefore, the Logistic Technicians would stockpile the interphase carts in the hallway until all the

supplies were received. Several Logistic Technicians would then converge and make the deliveries at one time. Such delivery times were excluded from time study.

A running daily log of Automated Guided Vehicle deliveries is maintained by the Supervisor of that section. Using that log, a random one week period was to be selected, which would be considered representative of the sites to which Automated Guided Vehicle deliveries were being made. However, the supervisor was able to identify multiple periods of time that elevators were dysfunctional, or clinics were unopened, or other extenuating circumstances had occurred. Since such little time had transpired since the opening of the hospital, a truly random period was not attainable. Therefore, the period of 01 - 06 (inclusive) March 1988 was chosen because in the supervisor's judgment, nothing had taken place during this period that had disrupted scheduled deliveries.

Within that selected period, the criteria for inclusion into the actual time study was: a) delivery made using the basic method; and, b) delivery made to those ultimate destinations whose distances to the closest material handling room had been previously measured. The stopwatch studies were conducted by two civilian employees trained in the industrial engineering field and hired for the purpose of conducting and analyzing such time studies. Their services were acquired for one week through the cooperation of the Officer in Charge of the Manpower Engineering Command, San Diego Detachment. Thus, the study was restricted to

one week in length, during which deliveries to all three buildings and during both shifts of operation were observed.

The Results

Appendix C compares the seventy-one stopwatch studies with the estimated delivery times to the respective areas. This estimated time was determined by assigning TMUs, based upon the distance traveled and the commodity delivered, and multiplying that number by .036 (1 TMU is equal to .036 of a second). The assumption was made that the differences observed between these two times constituted a sample drawn from a normally distributed population of differences.

Alpha (α) was chosen to be .05. The Student's T distribution was chosen as appropriate for the test statistic, with (n-1) or 70 degrees of freedom. The critical value of the test statistic (t) was located in statistical tables to be 1.9945. The Mean of the differences was 13.41, the Standard Deviation of the differences was 106.25. Therefore, the computed value of (t) was 1.06. Since the computed value is less than the critical value, we fail to reject (or "accept") the hypothesis of no difference. Thus, based upon this paired comparison test, the application of the standard time values obtained from the Department of Defense Work Measurement Standard Time Data Program to the operations involving the automated material delivery system is statistically valid.

IV CONCLUSION

To reiterate, the development of standard times in this study was the keystone of this study. Once the delivery sites were identified and the delivery schedule ascertained, these standard times could be applied to determine the minimum manpower required. This was the objective of this study. However, the above objective can not be met at this time for several reasons, all of which are beyond the control of the author; some of which are outside of the control of the facility itself.

The problems delineated below were identified by the individuals conducting the actual time study phase of this project or else personally conveyed to the author by individuals working closely with the automated material delivery system. Those problems which adversely impacted on the achievement of this project's objective were:

* The Naval Hospital San Diego has not yet received the General Purpose carts needed to transport dirty linen and trash via the automated material delivery system.

When this project was initially being developed, the General Purpose Carts were anticipated to be on board. When this did not occur, Time Measured Units (TMUs) could not be applied to the elements of the operations that involved these carts. Therefore,

the standard time required for the transfer of linen and trash could not be incorporated into this study.

* Failure to use specific areas to receive C-lockers delivered via the Automated Guided Vehicle system.

The author measured all of the distances between the material handling rooms and those rooms identified in the architectural drawings as "supply rooms", "storage rooms", "utility rooms" or similar nomenclature. Also measured were those rooms or areas in which installation of C-locker railing was planned. 214 such spaces were identified, and the respective distance to the nearest material handling room was recorded. However, for the convenience of the ward or clinic staff, or due to the lack of railing installation, C-lockers are being delivered to hallways or other nonspecific locations. A Standard Time System depends upon standard methods of operation, which means that the medical material must be delivered to the same site every time. It cannot vary, because the distance between the site and the material handling room is preeminent in the calculation of Time Measured Units (TMUs) for the operation.

* The lack of strong, central management of the automated material delivery system. This is evidenced by:

- Several ward or clinic personnel concurrently dictating C-locker contents and replenishment schedules thus confusing General Stores personnel.

- Medical Supply Carrousel Storage System personnel and Linen personnel failing to dispatch their respective Automated Guided Vehicle loads in a proper and timely fashion.

- Department heads refusing to cooperate with the new modality of delivering supplies.

V SUMMARY

In summary, the purpose of the study was to determine the minimum manpower requirements for the American Sterilizer Company automated material distribution system at the new Naval Hospital San Diego. To achieve this purpose, the Department of Defense Work Measurement Standard Time Data Program was used to apply predetermined Time Measured Units (TMUs) to each element of the operations involving Logistic Technicians. Such an application of a standard time system had not previously been applied in a healthcare setting to an automated medical material delivery system. Actual time study observations were made of seventy one deliveries using the described basic method. These observations statistically validated the application of the selected standard

time system to the described elements of operation. Several problems were identified which prevented the author from fully achieving the stated goal of determining the minimum manpower requirements for this automated delivery system. However, a microcomputer model in the form of a spreadsheet was provided to the facility to assist them in making this determination once the aforementioned problems are resolved.

This spreadsheet consists of one column containing the distances previously measured from material handling rooms to several hundred identified storage rooms. Additions to this column can be made to reflect the distances of deliveries actually occurring. Another column contains the TMUs for each commodity being transported; either an interphase cart with one or two C-lockers, or a general purpose cart. Other columns calculate the total time required to conduct the deliveries. The recipient of this spreadsheet will then be able identify the total time required to make deliveries originating from individual material handling rooms, determine the peaks and valleys of the delivery workload, and make adjustments to smooth out that workload.

VI RECOMMENDATIONS

The major problem affecting the immediate utilization of the results of this study is the lack of general purpose carts. Upon receipt of these carts, the following recommendations are made:

* Utilize the Time Measured Units (TMUs) estimated for the transfer of material via general purpose carts as contained in Appendix D.

* Identify the ultimate destinations for ALL material conveyed via the automated material delivery system and handled by the Logistic Technicians.

Appendix E contains the distances previously measured by the author. The distance to any destination currently being used that is not contained with Appendix E should be measured and recorded. The spreadsheet used in this study for calculating standard times will be provided to the facility and will allow for such additions.

* Using the total estimated time, apply OPNAV Instruction 1000.16E to determine the workweeks required to make all of the deliveries via the automated delivery system.

* Assess the current delivery schedule and develop a flowchart reflecting all deliveries to each Material Handling Room. Apply the estimated time for delivery to the areas receiving deliveries. Incorporate those deliveries that do not involve Logistic Technicians (Food Service deliveries, for example) since they do take up elevator time and use the Automated Guided Vehicles (AGVs).

This should reveal "peaks and valleys" of deliveries with their concomitant manpower requirements. Reassessment of the medical material delivery schedules can then determine the methodology for smoothing out the manpower requirements. This could be effected by either combining several deliveries or spreading out deliveries during the course of the day.

* Incorporate the estimated time for deliveries into the civilian performance appraisal report. It provides a quantitative method of evaluating the work performed.

It is the opinion of the author that the benefit to the facility in accepting and implementing these recommendations will be:

* The reduction of Logistic Technicians required to perform the current level of medical material deliveries.

* That future requests for personnel will be quantitatively justified and easily adjusted as workload changes.

* The improved hiring flexibility, as the decision between hiring a part time employee versus a full time employee can be quantifiably determined.

* That civilian personnel evaluations can now be based upon quantitative measurements.

APPENDIX A

Standard Time Assignments for Operations Involving 2 C-lockers *DoD 5010.15.1-M

Vernacular Desc.	Operation/element Desc.	TMU's	Source*	Complete description	Est. TMU's
Grasp and maneuver interphase cart to door.	Platform truck-four wheel-hand. Start/Stop Fwd. <500#	93 11	volume 09 pg 210	Starts-with hands on handles ready to push. Includes-all the time necessary to push a hand truck,loaded or empty, for one foot. Ends-after moving hand cart for one foot.	Full <500# Ave. Dist=5' Start/stop = 270 11 tmu * 5'= 55 325 TMUs
Open door, allow the door to close automatically.	Door(passage), open & close quick release, pull to open with automatic closure.	127	volume 10 pg 64	Starts-with reach to knob. Includes-all motions necessary to release latch, pull door open,walk thru & release door. Ends-with release of door.	127 TMUs
Maneuver interphase cart through door.	Platform truck-four wheel-hand. Start/Stop Fwd. <500#	93 11	volume 09 pg 210	Starts-with hands on handles ready to push. Includes-all the time necessary to push a hand truck,loaded or empty, for one foot. Ends-after moving hand cart for one foot.	Full <500# Ave. Dist=3' 11 tmu * 3'= 33 33 TMUs
Push interphase cart to ultimate destination.	Platform truck-four wheel-hand. Start/Stop Fwd. <500#	93 11	volume 09 pg 210	Starts-with hands on handles ready to push. Includes-all the time necessary to push a hand truck,loaded or empty, for one foot. Ends-after moving hand cart for one foot.	Distance * 11 = varies ? TMUs
Secure wheels of interphase cart.	Lever, engage or disengage.	34	volume 10 pg 03	Starts-with reach for lever. Includes-apply pressure and move lever up to nine inches. Ends-with release of lever.	Two (2) wheels of with brake. 68 TMUs

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Standard Time Assignments for Operations Involving 2 C-lockers *DoD 5010.15.1-M

Vernacular Desc.	Operation/element Desc.	TMU's	Source*	Complete description	Est. TMU's
Unlock safety lock of interphase cart (done by hand).	Turnlock(fasten or unfasten)	69	volume 10 pg 54	Starts-with reach to part. Includes-all motions necessary to accomplish minor repositioning & turn up to 90°. Ends-with release.	69 TMUs
Swing C-lockers clockwise.	Object,turn about vertical axis to 180°. Object attached to fixture; Effective Net Resistance (ENR) up to 50 #.	variable	volume 10 pg 67	Starts-with reach to obj. Includes-all motions necessary to cause rotation. Ends-with release of obj.	Radius of object 25(inches) ENR = <2.5(pounds) Turned 90° 74 TMUs [determined - table]
Concurrently lower both C-lockers using the respective wheels.	1. Wheel, move rim. 2. Wheel,shift grasp and turn 1/3 revolution. Effective Net Resistance (ENR) up to 35 #	from table	volume 10 1. pg 05 2. pg 06	1. Starts-with hands on rim. Includes-all motions necessary to move rim of wheel with or without pressure. Ends-with hands on rim. 2. Starts-with hands on rim. Includes-all motions necessary to shift the grasp on the rim and turn wheel 1/3 revolution. Ends-with hands on the wheel.	1. ENR (pounds) required to move rim. [35#] (1-3 ") = 14 TMUs 2. Distance rim moved (inches) = 29 ENR (pounds) = 1 1/3 turn = 24 TMUs (requires 1.6 revs.) [24*5] =120 TMUs 14+120 = 134 TMUs
Obtain first TR-3 from original location.	Cart,(empty), push aside.	262	volume 09 pg 206	Starts-with step to cart. Includes-all the time nec. to release cart brakes, grasp handle,push aside, stop and release cart. Ends with release of cart.	[Condition:move cart 4 paces-step 2 paces to cart.] 262 TMUs

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Standard Time Assignments for Operations Involving 2 C-lockers *DoD 5010.15.1-M

Vernacular Desc.	Operation/element Desc.	TMU's	Source*	Complete description	Est. TMU's
Position first TR-3 under first C-locker to be replenished on hanger rail.	Truck(hand-2 wheel), load and unload.	346	volume 09 pg 208	Starts-with a step to truck axel. Includes-all the time necessary to push a hand truck under a load. (includes tilting the load),set truck for move, tilt truck to upright to floor, tilt load, pull truck from under, balance truck. Ends-with empty truck at balance.	346
Step on pedal to dislodge C-locker from hanger rail.	Pedal, depress	33	volume 10 pg 01	Starts-with move foot to pedal. Includes-all motion nec. to utilize pressure to depress a pedal. Ends-with movement of foot away from pedal.	33
					379 TMUs
Maneuver first C-locker to be replenished out of the way.	Platform truck-four wheel-hand. Start/Stop Fwd. <500#	93 11	volume 09 pg 210	Starts-with hands on handles ready to push. Includes-all the time necessary to push a hand truck,loaded or empty, for one foot. Ends-after moving hand cart for one foot.	Full <500# Ave. Dist=3' Start/stop = 93 11 tmu * 3'= 33 126 TMUs
Obtain second TR-3 from original location.	Cart,(empty), push aside.	262	volume 09 pg 206	Starts-with step to cart. Includes-all the time nec. to release cart brakes, grasp handle,push aside, stop and release cart. Ends with release of cart.	[Condition:move cart 4 paces-step 2 paces to cart.] 262 TMUs

APPENDIX A

Standard Time Assignments for Operations Involving 2 C-lockers *DoD 5010.15.1-M

Vernacular Desc.	Operation/element Desc.	TMU's	Source*	Complete description	Est. TMU's
Position second TR-3 under first full C-locker on interphase cart.	Truck(hand-2 wheel), load and unload.	346	volume 09 pg 208	Starts-with a step to truck axel. Includes-all the time necessary to push a hand truck under a load. (includes tilting the load),set truck for move, tilt truck to upright to floor, tilt load, pull truck from under, balance truck. Ends-with empty truck at balance.	346
Step on pedal to dislodge C-locker from interphase cart.	Pedal, depress	33	volume 10 pg 01	Starts-with move foot to pedal. Includes-all motion nec. to utilize pressure to depress a pedal. Ends-with movement of foot away from pedal.	33
					379 TMUs
Maneuver first full C-locker to empty space on hanger rail.	Platform truck-four wheel-hand.		volume 09 pg 210	Starts-with hands on handles ready to push. Includes-all the time necessary to push a hand truck,loaded or empty, for one foot. Ends-after moving hand cart for one foot.	Full <500# Ave. Dist=3'
	Start/Stop Fwd.				Start/stop = 93
	<500#	93 11			11 tmu * 3'= 33
					126 TMUs

APPENDIX A

Standard Time Assignments for Operations Involving 2 C-lockers *DoD 5010,15.1-M

Vernacular Desc.	Operation/element Desc.	TMU's	Source*	Complete description	Est. TMU's
Position first full C- locker on TR-3 to empty position on hanger wall.	Truck(hand-2 wheel), load and unload.	346	volume 09 pg 208	Starts-with a step to truck axel. Includes-all the time necessary to push a hand truck under a load. (includes tilting the load),set truck for move, tilt truck to upright to floor, tilt load, pull truck from under, balance truck. Ends-with empty truck at balance.	346
Step on pedal to dislodge C-locker from TR-3 to hanger wall.	Pedal, depress	33	volume 10 pg 01	Starts-with move foot to pedal. Includes-all motion nec. to utilize pressure to depress a pedal. Ends-with movement of foot away from pedal.	33 379 TMUs
Position second TR-3 under second C-locker to be replenished on hanger wall.	Truck(hand-2 wheel), load and unload.	346	volume 09 pg 208	Starts-with a step to truck axel. Includes-all the time necessary to push a hand truck under a load. (includes tilting the load),set truck for move, tilt truck to upright to floor, tilt load, pull truck from under, balance truck. Ends-with empty truck at balance.	346
Step on pedal to dislodge C-locker from hanger wall.	Pedal, depress	33	volume 10 pg 01	Starts-with move foot to pedal. Includes-all motion nec. to utilize pressure to depress a pedal. Ends-with movement of foot away from pedal.	33 379 TMUs

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Standard Time Assignments for Operations Involving 2 C-lockers *DoD 5010.15.1-M

Vernacular Desc.	Operation/element Desc.	TMU's	Source*	Complete description	Est. TMU's
Maneuver second C-locker to be replenished to interphase cart.	Platform truck-four wheel-hand. Start/Stop Fwd. <500#	93 11	volume 09 pg 210	Starts-with hands on handles ready to push. Includes-all the time necessary to push a hand truck,loaded or empty, for one foot. Ends-after moving hand cart for one foot.	Full <500# Ave. Dist=3' Start/stop = 93 11 tmu * 3'= 33 126 TMUs
Position second C-locker to be replenished to interphase cart.	Truck(hand-2 wheel), load and unload.	346	volume 09 pg 208	Starts-with a step to truck axel. Includes-all the time necessary to push a hand truck under a load. (includes tilting the load),set truck for move, tilt truck to upright to floor, tilt load, pull truck from under, balance truck. Ends-with empty truck at balance.	346
Step on pedal to dislodge C-locker from TR-3 to interphase cart.	Pedal, depress	33	volume 10 pg 01	Starts-with move foot to pedal. Includes-all motion nec. to utilize pressure to depress a pedal. Ends-with movement of foot away from pedal.	33 379 TMUs

APPENDIX A

Standard Time Assignments for Operations Involving 2 C-lockers *DoD 5010.15.1-M

Vernacular Desc.	Operation/element Desc.	TMU's	Source*	Complete description	Est. TMU's
Position TR-3 under second full C-locker on interphase cart.	Truck(hand-2 wheel), load and unload.	346	volume 09 pg 208	Starts-with a step to truck axel. Includes-all the time necessary to push a hand truck under a load. (includes tilting the load),set truck for move, tilt truck to upright to	
Step on pedal to dislodge C-locker from interphase cart onto TR-3.	Pedal, depress	33	volume 10 pg 01	floor, tilt load, pull truck from under, balance truck. Ends-with empty truck at balance.	346
				Starts-with move foot to pedal. Includes-all motion nec. to utilize pressure to depress a pedal. Ends-with movement of foot away from pedal.	33
					379 TMUs
Maneuver second full C-locker to empty space on hanger wall.	Platform truck-four wheel-hand.		volume 09 pg 210	Starts-with hands on handles ready to push. Includes-all the time necessary to push a hand truck,loaded or empty, for one foot.	Full <500# Ave. Dist=3'
	Start/Stop Fwd.				Start/stop = 93
	<500#	93 11		Ends-after moving hand cart for one foot.	11 tmu * 3'= 33
					126 TMUs

APPENDIX A

Standard Time Assignments for Operations Involving 2 C-lockers *DoD 5010.15.1-M

Vernacular Desc.	Operation/element Desc.	TMU's	Source*	Complete description	Est. TMU's
Position TR-3 under empty space on hanger wall.	Truck(hand-2 wheel), load and unload.	346	volume 09 pg 208	Starts-with a step to truck axel. Includes-all the time necessary to push a hand truck under a load. (includes tilting the load),set truck for move, tilt truck to upright to floor, tilt load, pull truck from under, balance truck. Ends-with empty truck at balance.	346
Step on pedal to dislodge C-locker from TR-3 to hanger wall.	Pedal, depress	33	volume 10 pg 01	Starts-with move foot to pedal. Includes-all motion nec. to utilize pressure to depress a pedal. Ends-with movement of foot away from pedal.	33 379 TMUs
Return second TR-3 to original location.	Cart,(empty), push aside.	262	volume 09 pg 206	Starts-with step to cart. Includes-all the time nec. to release cart brakes, grasp handle,push aside, stop and release cart. Ends with release of cart.	[Condition:move cart 4 paces-step 2 paces to cart.] 262 TMUs
Maneuver first C-locker to be replenished to interphase cart.	Platform truck-four wheel-hand. Start/Stop Fwd. <500#	93 11	volume 09 pg 210	Starts-with hands on handles ready to push. Includes-all the time necessary to push a hand truck,loaded or empty, for one foot. Ends-after moving hand cart for one foot.	Full <500# Ave. Dist=3' Start/stop = 93 11 tmu * 3'= 33 126 TMUs

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Standard Time Assignments for Operations Involving 2 C-lockers *DoD 5010.15.1-M

Vernacular Desc.	Operation/element Desc.	TMU's	Source*	Complete description	Est. TMU's
Position first C-locker to be replenished to interphase cart.	Truck(hand-2 wheel), load and unload.	346	volume 09 pg 208	Starts-with a step to truck axel. Includes-all the time necessary to push a hand truck under a load. (includes tilting the load),set truck for move, tilt truck to upright to f.oor, tilt load, pull truck from under, balance truck. Ends-with empty truck at balance.	346
Step on pedal to dislodge C-locker from TR-3 to interphase cart.	Pedal, depress	33	volume 10 pg 01	Starts-with move foot to pedal. Includes-all motion nec. to utilize pressure to depress a pedal. Ends-with movement of foot away from pedal.	33 379 TMUs
Return first TR-3 to original location.	Cart,(empty), push aside.	262	volume 09 pg 206	Starts-with step to cart. Includes-all the time nec. to release cart brakes, grasp handle,push aside, stop and release cart. Ends with release of cart.	[Condition:move cart 4 paces-step 2 paces to cart.] 262 TMUs
Swing C-lockers counterclockwise.	Object,turn about vertical axis to 180°. Object attached to fixture; Effective Net Resistance (ENR) up to 50 #.	from table	volume 10 pg 67	Starts-with reach to obj. Includes-all motions necessary to cause rotation. Ends-with release of obj.	Radius of object 25(inches) ENR = <2.5(pounds) Turned 90° 74 TMUs
Lock safety lock of interphase cart (done by hand).	Turnlock(fasten or unfasten)	69	volume 10 pg 54	Starts-with reach to part. Includes-all motions necessary to accomplish minor repositioning & turn up to 90°. Ends-with release.	69 TMUs

APPENDIX A

Standard Time Assignments for Operations Involving 2 C-lockers *DoD 5010.15.1-M

Vernacular Desc.	Operation/element Desc.	TMU's	Source*	Complete description	Est. TMU's
Concurrently raise both C-lockers using the respective wheels.	1. Wheel, move rim. 2. Wheel, shift grasp and turn 1/3 revolution. Effective Net Resistance (ENR) up to 35 #	from table	volume 10 1. pg 05 2. pg 06	1. Starts-with hands on rim. Includes-all motions necessary to move rim of wheel with or without pressure. Ends-with hands on rim. 2. Starts-with hands on rim. Includes-all motions necessary to shift the grasp on the rim and turn wheel 1/3 revolution. Ends-with hands on the wheel.	1. ENR (pounds) required to move rim. [35#] (1-3 ") = 14 TMUs 2. Distance rim moved (inches) = 29 ENR (pounds) = 1 1/3 turn = 24 TMUs (requires 1.6 revs.) [24*5] =120 TMUs 14+120 = 134 TMUs
Release wheels of interphase cart.	Lever, engage or disengage.	34	volume 10 pg 03	Starts-with reach for lever. Includes-apply pressure and move lever up to nine inches. Ends-with release of lever.	Two (2) wheels of with brake. 68 TMUs
Push interphase cart to material handling room.	Platform truck-four wheel-hand. Start/Stop Fwd. <500#	 93 11	volume 09 pg 210	Starts-with hands on handles ready to push. Includes-all the time necessary to push a hand truck, loaded or empty, for one foot. Ends-after moving hand cart for one foot.	Start/stop = 270 Distance * 11 = varies ? TMUs
Open door, allow the door to close automatically.	Door(passage), open & close quick release, pull to open with automatic closure.	127	volume 10 pg 64	Starts-with reach to knob. Includes-all motions necessary to release latch, pull door open, walk thru & release door. Ends-with release of door.	 127 TMUs

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Standard Time Assignments for Operations Involving 2 C-lockers *DoD 5010.15.1-M

Vernacular Desc.	Operation/element Desc.	TMU's	Source*	Complete description	Est. TMU's
Maneuver interphase cart through door.	Platform truck-four wheel-hand. Start/Stop Fwd. <500#	93 11	volume 09 pg 210	Starts-with hands on handles ready to push. Includes-all the time necessary to push a hand truck,loaded or empty, for one foot. Ends-after moving hand cart for one foot.	Full <500# Ave. Dist=3' 11 tmu * 3'= 33 33 TMUs
Maneuver interphase cart to sending spur. (Interphase cart must be positioned exactly.)	Platform truck-four wheel-hand. Start/Stop Fwd. <500#	93 11	volume 09 pg 210	Starts-with hands on handles ready to push. Includes-all the time necessary to push a hand truck,loaded or empty, for one foot. Ends-after moving hand cart for one foot.	Full <500# Ave. Dist=5' 11 tmu * 5'= 55 55 TMUs
Walk to control panel.		5.2 TMUs per foot	Maynard 5-40		Distance varies Average = 7.67 ft. 7.67*5.2 + 40 TMUs
Select proper destination for interphase now on sending spur.	Switches,operate, control panel.	2 TMUs	volume 10 pg 03	Starts-with a reach to the switch. Includes-all intermediate reaches and swith activations. Ends-with a reaching away from the control panel to ready position.	2 TMUs

APPENDIX B

Standard Time Assignments for Operations involving 1 C-locker *DoD 5010.15.1-M

Vernacular Desc.	Operation/element Desc.	TMU's	Source*	Complete description	Est. TMU's
Grasp and maneuver interphase cart to door.	Platform truck-four wheel-hand. Start/Stop Fwd. <500#	93 11	volume 09 pg 210	Starts-with hands on handles ready to push. Includes-all the time necessary to push a hand truck,loaded or empty, for one foot. Ends-after moving hand cart for one foot.	Full <500# Ave. Dist=5' Start/stop = 270 11 tmu * 5'= 55 325 TMUs
Open door, allow the door to close automatically.	Door(passage), open & close quick release, pull to open with automatic closure.	127	volume 10 pg 64	Starts-with reach to knob. Includes-all motions necessary to release latch, pull door open,walk thru & release door. Ends-with release of door.	127 TMUs
Maneuver interphase cart through door.	Platform truck-four wheel-hand. Start/Stop Fwd. <500#	93 11	volume 09 pg 210	Starts-with hands on handles ready to push. Includes-all the time necessary to push a hand truck,loaded or empty, for one foot. Ends-after moving hand cart for one foot.	Full <500# Ave. Dist=3' 11 tmu * 3'= 33 33 TMUs
Push interphase cart to ultimate destination.	Platform truck-four wheel-hand. Start/Stop Fwd. <500#	93 11	volume 09 pg 210	Starts-with hands on handles ready to push. Includes-all the time necessary to push a hand truck,loaded or empty, for one foot. Ends-after moving hand cart for one foot.	Distance * 11 = varies ? TMUs
Secure wheels of interphase cart.	Lever, engage or disengage.	34	volume 10 pg 03	Starts-with reach for lever. Includes-apply pressure and move lever up to nine inches. Ends-with release of lever.	Two (2) wheels of with brake. 68 TMUs

APPENDIX B

Standard Time Assignments for Operations involving 1 C-locker *DoD 5010.15.1-M

Vernacular Desc.	Operation/element Desc.	TMU's	Source*	Complete description	Est. TMU's
Unlock safety lock of interphase cart (done by hand).	Turnlock(fasten or unfasten)	69	volume 10 pg 54	Starts-with reach to part. Includes-all motions necessary to accomplish minor repositioning & turn up to 90°. Ends-with release.	69 TMUs
Swing C-locker clockwise.	Object,turn about vertical axis to 180°. Object attached to fixture; Effective Net Resistance (ENR) up to 50 #.	variable	volume 10 pg 67	Starts-with reach to obj. Includes-all motions necessary to cause rotation. Ends-with release of obj.	Radius of object 25(inches) ENR = <2.5(pounds) Turned 90° 74 TMUs [determined - table]
Concurrently lower both C-locker hangers using the respective wheels.	1. Wheel, move rim. 2. Wheel,shift grasp and turn 1/3 revolution.	from table	volume 10 1. pg 05 2. pg 06	1. Starts-with hands on rim. Includes-all motions necessary to move rim of wheel with or without pressure. Ends-with hands on rim. 2. Starts-with hands on rim. Includes-all motions necessary to shift the grasp on the rim and turn wheel 1/3 revolution. Ends-with hands on the wheel.	1. ENR (pounds) required to move rim. [35#] (1-3 ") = 14 TMUs 2. Distance rim moved (inches) = 29 ENR (pounds) = 1 1/3 turn = 24 TMUs (requires 1.6 revs.) [24*5] =120 TMUs 14+120 = 134 TMUs
Obtain TR-3 from original position.	Cart,(empty), push aside.	262	volume 09 pg 206	Starts-with step to cart. Includes-all the time nec. to release cart brakes, grasp handle,push aside, stop and release cart. Ends with release of cart.	[Condition:move cart 4 paces-step 2 paces to cart.] 262 TMUs

APPENDIX B

Standard Time Assignments for Operations involving 1 C-locker *DoD 5010.15.1-M

Vernacular Desc.	Operation/element Desc.	TMU's	Source*	Complete description	Est. TMU's
Position TR-3 under C-locker to be replenished on hanger rail.	Truck(hand-2 wheel), load and unload.	346	volume 09 pg 208	Starts-with a step to truck axel. Includes-all the time necessary to push a hand truck under a load. (includes tilting the load),set truck for move, tilt truck to upright to floor, tilt load, pull truck from under, balance truck. Ends-with empty truck at balance.	346
Step on pedal to dislodge C-locker from hanger rail.	Pedal, depress	33	volume 10 pg 01	Starts-with move foot to pedal. Includes-all motion nec. to utilize pressure to depress a pedal. Ends-with movement of foot away from pedal.	33
					379 TMUs
Maneuver C-locker to be replenished to interphase cart.	Platform truck-four wheel-hand.		volume 09 pg 210	Starts-with hands on handles ready to push. Includes-all the time necessary to push a hand truck,loaded or empty, for one foot. Ends-after moving hand cart for one foot.	Full <500# Ave. Dist=3'
	Start/Stop Fwd.				Start/stop = 93
	<500#	93 11			11 tmu * 3'= 33
					126 TMUs

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Standard Time Assignments for Operations involving 1 C-locker *DoD 5010.15.1-M

Vernacular Desc.	Operation/element Desc.	TMU's	Source*	Complete description	Est. TMU's
Position TR-3 with C-locker to be replenished to interphase cart.	Truck(hand-2 wheel), load and unload.	346	volume 09 pg 208	Starts-with a step to truck axel. Includes-all the time necessary to push a hand truck under a load. (includes tilting the load),set truck for move, tilt truck to upright to floor, tilt load, pull truck from under, balance truck. Ends-with empty truck at balance.	346
Step on pedal to dislodge C-locker from TR-3 to interphase cart.	Pedal, depress	33	volume 10 pg 01	Starts-with move foot to pedal. Includes-all motion nec. to utilize pressure to depress a pedal. Ends-with movement of foot away from pedal.	33 379 TMUs
Position TR-3 under full C-locker on interphase cart.	Truck(hand-2 wheel), load and unload.	346	volume 09 pg 208	Starts-with a step to truck axel. Includes-all the time necessary to push a hand truck under a load. (includes tilting the load),set truck for move, tilt truck to upright to floor, tilt load, pull truck from under, balance truck. Ends-with empty truck at balance.	346
Step on pedal to dislodge C-locker from interphase cart onto TR-3.	Pedal, depress	33	volume 10 pg 01	Starts-with move foot to pedal. Includes-all motion nec. to utilize pressure to depress a pedal. Ends-with movement of foot away from pedal.	33 379 TMUs

APPENDIX B

Standard Time Assignments for Operations involving 1 C-locker *DoD 5010.15.1-M

Vernacular Desc.	Operation/element Desc.	TMU's	Source*	Complete description	Est. TMU's
Maneuver full C-locker to empty space on hanger wall.	Platform truck-four wheel-hand. Start/Stop Fwd. <500#	93 11	volume 09 pg 210	Starts-with hands on handles ready to push. Includes-all the time necessary to push a hand truck,loaded or empty, for one foot. Ends-after moving hand cart for one foot.	Full <500# Ave. Dist=3' Start/stop = 93 11 tmu * 3'= 33 126 TMUs
Position TR-3 under empty space on hanger wall.	Truck(hand-2 wheel), load and unload.	346	volume 09 pg 208	Starts-with a step to truck axel. Includes-all the time necessary to push a hand truck under a load. (includes tilting the load),set truck for move, tilt truck to upright to	
Step on pedal to dislodge C-locker from TR-3 to hanger wall.	Pedal, depress	33	volume 10 pg 01	floor, tilt load, pull truck from under, balance truck. Ends-with empty truck at balance.	346
				Starts-with move foot to pedal. Includes-all motion nec. to utilize pressure to depress a pedal. Ends-with movement of foot away from pedal.	33 379 TMUs
Return TR-3 to original location.	Cart,(empty), push aside.	262	volume 09 pg 206	Starts-with step to cart. Includes-all the time nec. to release cart brakes, grasp handle,push aside, stop and release cart. Ends with release of cart.	[Condition:move cart 4 paces-step 2 paces to cart.] 262 TMUs
Swing C-locker counterclockwise.	Object,turn about vertical axis to 180°. Object attached to fixture; Effective Net Resistance (ENR) up to 50 #.	variable	volume 10 pg 67	Starts-with reach to obj. Includes-all motions necessary to cause rotation. Ends-with release of obj.	Radius of object 25(inches) ENR = <2.5(pounds) Turned 90° 74 TMUs [determined - table]

APPENDIX B

Standard Time Assignments for Operations involving 1 C-locker *DoD 5010.15.1-M

Vernacular Desc.	Operation/element Desc.	TMU's	Source*	Complete description	Est. TMU's
Lock safety lock of interphase cart (done by hand).	Turnlock(fasten or unfasten)	69	volume 10 pg 54	Starts-with reach to part. Includes-all motions necessary to accomplish minor repositioning & turn up to 90°. Ends-with release.	69 TMUs
Concurrently raise both C-locker hangers using the respective wheels.	1. Wheel, move rim. 2. Wheel,shift grasp and turn 1/3 revolution. Effective Net Resistance (ENR) up to 35 #	from table	volume 10 1. pg 05 2. pg 06	1. Starts-with hands on rim. Includes-all motions necessary to move rim of wheel with or without pressure. Ends-with hands on rim. 2. Starts-with hands on rim. Includes-all motions necessary to shift the grasp on the rim and turn wheel 1/3 revolution. Ends-with hands on the wheel.	1. ENR (pounds) required to move rim. [35#] (1-3 ") = 14 TMUs 2. Distance rim moved (inches) = 29 ENR (pounds) = 1 1/3 turn = 24 TMUs (requires 1.6 revs.) [24*5] =120 TMUs 14+120 = 134 TMUs
Release wheels of interphase cart.	Lever, engage or disengage.	34	volume 10 pg 03	Starts-with reach for lever. Includes-apply pressure and move lever up to nine inches. Ends-with release of lever.	Two (2) wheels of with brake. 68 TMUs
Push interphase cart to material handling room.	Platform truck-four wheel-hand. Start/Stop Fwd. <500#	 93 11	volume 09 pg 210	Starts-with hands on handles ready to push. Includes-all the time necessary to push a hand truck,loaded or empty, for one foot. Ends-after moving hand cart for one foot.	Start/stop = 270 Distance * 11 = varies ? TMUs
Open door, allow the door to close automatically.	Door(passage), open & close quick release, pull to open with automatic closure.	127	volume 10 pg 64	Starts-with reach to knob. Includes-all motions necessary to release latch, pull door open,walk thru & release door. Ends-with release of door.	127 TMUs

APPENDIX B

Standard Time Assignments for Operations involving 1 C-locker *DoD 5010.15.1-M

Vernacular Desc.	Operation/element Desc.	TMU's	Source*	Complete description	Est. TMU's
Maneuver interphase cart through door.	Platform truck-four wheel-hand. Start/Stop Fwd. <500#	93 11	volume 09 pg 210	Starts-with hands on handles ready to push. Includes-all the time necessary to push a hand truck,loaded or empty, for one foot. Ends-after moving hand cart for one foot.	Full <500# Ave. Dist=3' 11 tmu * 3'= 33 33 TMUs
Maneuver interphase cart to sending spur. (Interphase cart must be positioned exactly.)	Platform truck-four wheel-hand. Start/Stop Fwd. <500#	93 11	volume 09 pg 210	Starts-with hands on handles ready to push. Includes-all the time necessary to push a hand truck,loaded or empty, for one foot. Ends-after moving hand cart for one foot.	Full <500# Ave. Dist=5' 11 tmu * 5'= 55 55 TMUs
Walk to control panel.		5.2 TMUs per foot	Maynard 5-40		Distance varies Average = 7.67 ft. 7.67*5.2 + 40 TMUs
Select proper destination for interphase now on sending spur.	Switches,operate, control panel.	2 TMUs	volume 10 pg 03	Starts-with a reach to the switch. Includes-all intermediate reaches and swith activations. Ends-with a reaching away from the control panel to ready position.	2 TMUs

APPENDIX C

Summary of Data for 71 Observations

Obs.	Building	Department	Room Number	Distance from MHR (in feet)	Distance to MHR (in feet)
1	ANCILLARY	PRIMARY CARE	1C13H4	606.00	606.00
2	SOUTH CLINIC	CHILD CARE NURSERY	1J0505	99.00	99.00
3	SOUTH CLINIC	PEDIATRIC CLINIC	1K1103	186.00	186.00
4	SOUTH CLINIC	PEDIATRIC CLINIC	1K1103	186.00	186.00
5	NORTH CLINIC	OB/GYN CLINIC	1L16S6	99.00	99.00
6	NORTH CLINIC	REHAB MEDICINE	1M22V4	244.00	244.00
7	NORTH CLINIC	REHAB MEDICINE	1M22V4	244.00	244.00
8	NORTH CLINIC	REHAB MEDICINE	1M22V4	244.00	244.00
9	NORTH CLINIC	REHAB MEDICINE	1M23S1	143.00	143.00
10	SOUTH CLINIC	OPHTHALMOLOGY	2J0201	144.00	144.00
11	SOUTH CLINIC	PLASTIC SURGERY	2K07Q2	89.00	89.00
12	NORTH CLINIC	UROLOGY CLINIC	2L14T1	144.00	144.00
13	NORTH CLINIC	UROLOGY CLINIC	2L14T1	144.00	144.00
14	NORTH CLINIC	UROLOGY CLINIC	2L14T1	144.00	144.00
15	NORTH CLINIC	NEUROLOGY	2M20R2	84.00	84.00
16	NORTH CLINIC	NEUROLOGY	2M20R2	84.00	84.00
17	NORTH CLINIC	RHEUMATOLOGY	2M23S1	157.00	157.00
18	NORTH CLINIC	RHEUMATOLOGY	2M23S1	157.00	157.00
19	NORTH CLINIC	RHEUMATOLOGY	2M23S1	157.00	157.00
20	NORTH CLINIC	RHEUMATOLOGY	2M23S1	157.00	157.00
21	NORTH CLINIC	RHEUMATOLOGY	2M23S1	157.00	157.00
22	WEST TOWER	NURSING WARD	2PP173	148.00	241.00
23	WEST TOWER	NURSING WARD	2PP173	148.00	241.00
24	WEST TOWER	NURSING WARD	2PP173	148.00	241.00
25	WEST TOWER	NURSING WARD	2PP173	148.00	241.00
26	WEST TOWER	NURSING WARD	2PP173	148.00	241.00
27	WEST TOWER	NURSING WARD	2PP173	148.00	241.00
28	NORTH TOWER	NURSING WARD	2QQ173	129.00	132.00
29	NORTH TOWER	NURSING WARD	2QQ173	129.00	132.00
30	NORTH TOWER	NURSING WARD	2QQ173	129.00	132.00
31	EAST TOWER	NURSING WARD	2RR151	233.00	186.00
32	ANCILLARY	DIALYSIS/NEPHROLOGY	3D18G1	251.00	251.00
33	ANCILLARY	DIALYSIS/NEPHROLOGY	3D18H1	251.00	251.00
34	ANCILLARY	LABOR AND DELIVERY	3G31E2	334.00	334.00
35	ANCILLARY	LABOR AND DELIVERY	3G31E2	334.00	334.00
36	ANCILLARY	LABOR AND DELIVERY	3G31E2	334.00	334.00
37	ANCILLARY	LABOR AND DELIVERY	3G31E2	334.00	334.00
38	ANCILLARY	NURSERY/NICU	3G35G5	134.00	226.00
39	ANCILLARY	NURSERY/NICU	3G35G5	134.00	226.00
40	ANCILLARY	NURSERY/NICU	3G35G5	134.00	226.00
41	WEST TOWER	NURSING WARD	3PP173	148.00	241.00
42	WEST TOWER	NURSING WARD	3PP173	148.00	241.00
43	WEST TOWER	NURSING WARD	3PP173	148.00	241.00
44	NORTH TOWER	NURSING WARD	3QQ173	129.00	132.00

APPENDIX C

Summary of Data for 71 Observations

Obs.	Building	Department	Room Number	TMUs total from traveling	TMUs total Using Basic Method	TMUS TOTAL
1	ANCILLARY	PRIMARY CARE	1C13H4	13332.00	6142.00	19474.00
2	SOUTH CLINIC	CHILD CARE NURSERY	1J0505	9207.00	6142.00	15349.00
3	SOUTH CLINIC	PEDIATRIC CLINIC	1K1103	9207.00	6142.00	15349.00
4	SOUTH CLINIC	PEDIATRIC CLINIC	1K1103	7348.00	6142.00	13490.00
5	NORTH CLINIC	OB/GYN CLINIC	1L16S6	5368.00	6142.00	11510.00
6	NORTH CLINIC	REHAB MEDICINE	1M22V4	4466.00	6142.00	10608.00
7	NORTH CLINIC	REHAB MEDICINE	1M22V4	4466.00	6142.00	10608.00
8	NORTH CLINIC	REHAB MEDICINE	1M22V4	4466.00	6142.00	10608.00
9	NORTH CLINIC	REHAB MEDICINE	1M23S1	7348.00	6142.00	13490.00
10	SOUTH CLINIC	OPHTHALMOLOGY	2J0201	5368.00	6142.00	11510.00
11	SOUTH CLINIC	PLASTIC SURGERY	2K07Q2	9207.00	6142.00	15349.00
12	NORTH CLINIC	UROLOGY CLINIC	2L14T1	4279.00	6142.00	10421.00
13	NORTH CLINIC	UROLOGY CLINIC	2L14T1	4279.00	6142.00	10421.00
14	NORTH CLINIC	UROLOGY CLINIC	2L14T1	4279.00	6142.00	10421.00
15	NORTH CLINIC	NEUROLOGY	2M20R2	5368.00	6142.00	11510.00
16	NORTH CLINIC	NEUROLOGY	2M20R2	3938.00	6142.00	10080.00
17	NORTH CLINIC	RHEUMATOLOGY	2M23S1	7348.00	6142.00	13490.00
18	NORTH CLINIC	RHEUMATOLOGY	2M23S1	7348.00	6142.00	13490.00
19	NORTH CLINIC	RHEUMATOLOGY	2M23S1	4609.00	6142.00	10751.00
20	NORTH CLINIC	RHEUMATOLOGY	2M23S1	3938.00	6142.00	10080.00
21	NORTH CLINIC	RHEUMATOLOGY	2M23S1	3938.00	6142.00	10080.00
22	WEST TOWER	NURSING WARD	2PP173	3938.00	6142.00	10080.00
23	WEST TOWER	NURSING WARD	2PP173	4279.00	6142.00	10421.00
24	WEST TOWER	NURSING WARD	2PP173	4279.00	6142.00	10421.00
25	WEST TOWER	NURSING WARD	2PP173	4279.00	6142.00	10421.00
26	WEST TOWER	NURSING WARD	2PP173	4092.00	6142.00	10234.00
27	WEST TOWER	NURSING WARD	2PP173	4279.00	6142.00	10421.00
28	NORTH TOWER	NURSING WARD	2QQ173	4279.00	6142.00	10421.00
29	NORTH TOWER	NURSING WARD	2QQ173	4279.00	6142.00	10421.00
30	NORTH TOWER	NURSING WARD	2QQ173	5522.00	6142.00	11664.00
31	EAST TOWER	NURSING WARD	2RR151	3014.00	6142.00	9156.00
32	ANCILLARY	DIALYSIS/NEPHROLOGY	3D18G1	4312.00	6142.00	10454.00
33	ANCILLARY	DIALYSIS/NEPHROLOGY	3D18H1	4279.00	6142.00	10421.00
34	ANCILLARY	LABOR AND DELIVERY	3G31E2	3454.00	6142.00	9596.00
35	ANCILLARY	LABOR AND DELIVERY	3G31E2	3454.00	6142.00	9596.00
36	ANCILLARY	LABOR AND DELIVERY	3G31E2	4312.00	6142.00	10454.00
37	ANCILLARY	LABOR AND DELIVERY	3G31E2	4312.00	6142.00	10454.00
38	ANCILLARY	NURSERY/NICU	3G35G5	4092.00	6142.00	10234.00
39	ANCILLARY	NURSERY/NICU	3G35G5	5522.00	6142.00	11664.00
40	ANCILLARY	NURSERY/NICU	3G35G5	2871.00	6142.00	9013.00
41	WEST TOWER	NURSING WARD	3PP173	2871.00	6142.00	9013.00
42	WEST TOWER	NURSING WARD	3PP173	2178.00	6142.00	8320.00
43	WEST TOWER	NURSING WARD	3PP173	4312.00	6142.00	10454.00
44	NORTH TOWER	NURSING WARD	3QQ173	3014.00	6142.00	9156.00

APPENDIX C

Summary of Data for 71 Observations

Obs.	Building	Department	Room Number	Time (seconds) TMUs total * .036 Estimated	Time (seconds) Actual	Difference (seconds)
1	ANCILLARY	PRIMARY CARE	1C13H4	701.06	430.00	271.06
2	SOUTH CLINIC	CHILD CARE NURSERY	1J0505	552.56	478.00	74.56
3	SOUTH CLINIC	PEDIATRIC CLINIC	1K1103	552.56	438.00	114.56
4	SOUTH CLINIC	PEDIATRIC CLINIC	1K1103	485.64	410.00	75.64
5	NORTH CLINIC	OB/GYN CLINIC	1L16S6	414.36	306.00	108.36
6	NORTH CLINIC	REHAB MEDICINE	1M22V4	381.89	302.00	79.89
7	NORTH CLINIC	REHAB MEDICINE	1M22V4	381.89	287.00	94.89
8	NORTH CLINIC	REHAB MEDICINE	1M22V4	381.89	267.00	114.89
9	NORTH CLINIC	REHAB MEDICINE	1M23S1	485.64	410.00	75.64
10	SOUTH CLINIC	OPHTHALMOLOGY	2J0201	414.36	312.00	102.36
11	SOUTH CLINIC	PLASTIC SURGERY	2K07Q2	552.56	499.00	53.56
12	NORTH CLINIC	UROLOGY CLINIC	2L14T1	375.16	372.00	3.16
13	NORTH CLINIC	UROLOGY CLINIC	2L14T1	375.16	378.00	-2.84
14	NORTH CLINIC	UROLOGY CLINIC	2L14T1	375.16	345.00	30.16
15	NORTH CLINIC	NEUROLOGY	2M20R2	414.36	391.00	23.36
16	NORTH CLINIC	NEUROLOGY	2M20R2	362.88	222.00	140.88
17	NORTH CLINIC	RHEUMATOLOGY	2M23S1	485.64	493.00	-7.36
18	NORTH CLINIC	RHEUMATOLOGY	2M23S1	485.64	492.00	-6.36
19	NORTH CLINIC	RHEUMATOLOGY	2M23S1	387.04	395.00	-7.96
20	NORTH CLINIC	RHEUMATOLOGY	2M23S1	362.88	280.00	82.88
21	NORTH CLINIC	RHEUMATOLOGY	2M23S1	362.88	229.00	133.88
22	WEST TOWER	NURSING WARD	2PP173	362.88	298.00	64.88
23	WEST TOWER	NURSING WARD	2PP173	375.16	266.00	109.16
24	WEST TOWER	NURSING WARD	2PP173	375.16	313.00	62.16
25	WEST TOWER	NURSING WARD	2PP173	375.16	236.00	139.16
26	WEST TOWER	NURSING WARD	2PP173	368.42	353.00	15.42
27	WEST TOWER	NURSING WARD	2PP173	375.16	483.00	-107.84
28	NORTH TOWER	NURSING WARD	2QQ173	375.16	334.00	41.16
29	NORTH TOWER	NURSING WARD	2QQ173	375.16	361.00	14.16
30	NORTH TOWER	NURSING WARD	2QQ173	419.90	437.00	-17.10
31	EAST TOWER	NURSING WARD	2RR151	329.62	353.00	-23.38
32	ANCILLARY	DIALYSIS/NEPHROLOGY	3D18G1	376.34	337.00	39.34
33	ANCILLARY	DIALYSIS/NEPHROLOGY	3D18H1	375.16	322.00	53.16
34	ANCILLARY	LABOR AND DELIVERY	3G31E2	345.46	227.00	118.46
35	ANCILLARY	LABOR AND DELIVERY	3G31E2	345.46	227.00	118.46
36	ANCILLARY	LABOR AND DELIVERY	3G31E2	376.34	609.00	-232.66
37	ANCILLARY	LABOR AND DELIVERY	3G31E2	376.34	268.00	108.34
38	ANCILLARY	NURSERY/NICU	3G35G5	368.42	371.00	-2.58
39	ANCILLARY	NURSERY/NICU	3G35G5	419.90	403.00	16.90
40	ANCILLARY	NURSERY/NICU	3G35G5	324.47	242.00	82.47
41	WEST TOWER	NURSING WARD	3PP173	324.47	319.00	5.47
42	WEST TOWER	NURSING WARD	3PP173	299.52	179.00	120.52
43	WEST TOWER	NURSING WARD	3PP173	376.34	315.00	61.34
44	NORTH TOWER	NURSING WARD	3QQ173	329.62	436.00	106.38

APPENDIX C

Summary of Data for 71 Observations

Obs.	Building	Department	Room Number	Distance from MHR (in feet)	Distance to MHR (in feet)
45	EAST TOWER	NURSING WARD	3RR173	228.00	164.00
46	EAST TOWER	NURSING WARD	3RR173	228.00	164.00
47	EAST TOWER	NURSING WARD	3RR173	228.00	164.00
48	EAST TOWER	NURSING WARD	3RR173	228.00	164.00
49	ANCILLARY	PACU	4E25H4	203.00	203.00
50	ANCILLARY	PACU	4E25H4	203.00	203.00
51	ANCILLARY	PACU	4E25H4	203.00	203.00
52	ANCILLARY	PACU	4E25H6	179.00	179.00
53	ANCILLARY	PACU	4E25H6	179.00	179.00
54	ANCILLARY	PACU	4E25H6	179.00	179.00
55	ANCILLARY	PACU	4E25H6	179.00	179.00
56	ANCILLARY	ICU #2	4G33E2	440.00	397.00
57	ANCILLARY	ICU #2	4G33E2	440.00	397.00
58	ANCILLARY	ICU #2	4G33E2	440.00	397.00
59	ANCILLARY	CCU	4H36H1	191.00	243.00
60	ANCILLARY	CCU	4H36H1	191.00	243.00
61	NORTH CLINIC	SURGERY CLINIC	4L15S3	137.00	137.00
62	NORTH CLINIC	SURGERY CLINIC	4L15S3	137.00	137.00
63	NORTH CLINIC	SURGERY CLINIC	4L15S3	137.00	137.00
64	WEST TOWER	NURSING WARD	5PP173	148.00	241.00
65	NORTH TOWER	NURSING WARD	5QQ173	129.00	132.00
66	NORTH TOWER	NURSING WARD	5QQ173	129.00	132.00
67	NORTH TOWER	NURSING WARD	5QQ173	129.00	132.00
68	NORTH TOWER	NURSING WARD	5QQ173	129.00	132.00
69	EAST TOWER	NURSING WARD	5RR173	228.00	164.00
70	EAST TOWER	NURSING WARD	5RR173	228.00	164.00
71	EAST TOWER	NURSING WARD	5RR173	228.00	164.00

APPENDIX C

Summary of Data for 71 Observations

Obs.	Building	Department	Room Number	TMUs total from traveling	TMUs total Using Basic Method	TMUs TOTAL
45	EAST TOWER	NURSING WARD	3RR173	3014.00	6142.00	9156.00
46	EAST TOWER	NURSING WARD	3RR173	4312.00	6142.00	10454.00
47	EAST TOWER	NURSING WARD	3RR173	1848.00	6142.00	7990.00
48	EAST TOWER	NURSING WARD	3RR173	2871.00	6142.00	9013.00
49	ANCILLARY	PACU	4E25H4	3168.00	6142.00	9310.00
50	ANCILLARY	PACU	4E25H4	3168.00	6142.00	9310.00
51	ANCILLARY	PACU	4E25H4	3146.00	6142.00	9288.00
52	ANCILLARY	PACU	4E25H6	3454.00	6142.00	9596.00
53	ANCILLARY	PACU	4E25H6	4312.00	6142.00	10454.00
54	ANCILLARY	PACU	4E25H6	2871.00	6142.00	9013.00
55	ANCILLARY	PACU	4E25H6	4312.00	6142.00	10454.00
56	ANCILLARY	ICU #2	4G33E2	3168.00	6142.00	9310.00
57	ANCILLARY	ICU #2	4G33E2	4774.00	6142.00	10916.00
58	ANCILLARY	ICU #2	4G33E2	2871.00	6142.00	9013.00
59	ANCILLARY	CCU	4H36H1	2871.00	6142.00	9013.00
60	ANCILLARY	CCU	4H36H1	3454.00	6142.00	9596.00
61	NORTH CLINIC	SURGERY CLINIC	4L15S3	4774.00	6142.00	10916.00
62	NORTH CLINIC	SURGERY CLINIC	4L15S3	2178.00	6142.00	8320.00
63	NORTH CLINIC	SURGERY CLINIC	4L15S3	1848.00	6142.00	7990.00
64	WEST TOWER	NURSING WARD	5PP173	2871.00	6142.00	9013.00
65	NORTH TOWER	NURSING WARD	5QQ173	2871.00	6142.00	9013.00
66	NORTH TOWER	NURSING WARD	5QQ173	3454.00	6142.00	9596.00
67	NORTH TOWER	NURSING WARD	5QQ173	3168.00	6142.00	9310.00
68	NORTH TOWER	NURSING WARD	5QQ173	1958.00	6142.00	8100.00
69	EAST TOWER	NURSING WARD	5RR173	3960.00	6142.00	10102.00
70	EAST TOWER	NURSING WARD	5RR173	3960.00	6142.00	10102.00
71	EAST TOWER	NURSING WARD	5RR173	3960.00	6142.00	10102.00

APPENDIX C

Summary of Data for 71 Observations

Obs.	Building	Department	Room Number	Time (seconds) TMUs total * .036 Estimated	Time (seconds) Actual	Difference (seconds)
45	EAST TOWER	NURSING WARD	3RR173	329.62	357.00	-27.38
46	EAST TOWER	NURSING WARD	3RR173	376.34	399.00	-22.66
47	EAST TOWER	NURSING WARD	3RR173	287.64	164.00	123.64
48	EAST TOWER	NURSING WARD	3RR173	324.47	402.00	-77.53
49	ANCILLARY	PACU	4E25H4	335.16	363.00	-27.84
50	ANCILLARY	PACU	4E25H4	335.16	251.00	84.16
51	ANCILLARY	PACU	4E25H4	334.37	226.00	108.37
52	ANCILLARY	PACU	4E25H6	345.46	309.00	36.46
53	ANCILLARY	PACU	4E25H6	376.34	569.00	-192.66
54	ANCILLARY	PACU	4E25H6	324.47	313.00	11.47
55	ANCILLARY	PACU	4E25H6	376.34	362.00	14.34
56	ANCILLARY	ICU #2	4G33E2	335.16	410.00	-74.84
57	ANCILLARY	ICU #2	4G33E2	392.98	352.00	40.98
58	ANCILLARY	ICU #2	4G33E2	324.47	320.00	4.47
59	ANCILLARY	CCU	4H36H1	324.47	322.00	2.47
60	ANCILLARY	CCU	4H36H1	345.46	570.00	-224.54
61	NORTH CLINIC	SURGERY CLINIC	4L15S3	392.98	363.00	29.98
62	NORTH CLINIC	SURGERY CLINIC	4L15S3	299.52	222.00	77.52
63	NORTH CLINIC	SURGERY CLINIC	4L15S3	287.64	201.00	86.64
64	WEST TOWER	NURSING WARD	5PP173	324.47	487.00	-162.53
65	NORTH TOWER	NURSING WARD	5QQ173	324.47	471.00	-146.53
66	NORTH TOWER	NURSING WARD	5QQ173	345.46	498.00	-152.54
67	NORTH TOWER	NURSING WARD	5QQ173	335.16	402.00	-66.84
68	NORTH TOWER	NURSING WARD	5QQ173	291.60	292.00	-0.40
69	EAST TOWER	NURSING WARD	5RR173	363.67	568.00	-204.33
70	EAST TOWER	NURSING WARD	5RR173	363.67	587.00	-223.33
71	EAST TOWER	NURSING WARD	5RR173	363.67	664.00	-300.33

Sum of Differences = 952.01
Sum of Differences Squared = 803069.15
Average of Differences = 13.41
Variance of Differences = 11290.06
Standard Deviation of Differences = 106.25

APPENDIX D

Standard Time Assignments for Operations Involving General Purpose Carts *DoD 5010.15.1-M

Vernacular Desc.	Operation/element Desc.	TMU's	Source*	Complete description	Est. TMU's
Grasp and maneuver empty general purpose cart to door.	Platform truck-four wheel-hand. Start/Stop Fwd. <500#	93 11	volume 09 pg 210	Starts-with hands on handles ready to push. Includes-all the time necessary to push a hand truck,loaded or empty, for one foot. Ends-after moving hand cart for one foot.	Full <500# Ave. Dist=5' Start/stop = 270 11 tmu * 5'= 55 325 TMUs
Open door, allow the door to close automatically.	Door(passage), open & close quick release, pull to open with automatic closure.	127	volume 10 pg 64	Starts-with reach to knob. Includes-all motions necessary to release latch, pull door open,walk thru & release door. Ends-with release of door.	127 TMUs
Maneuver empty general purpose cart through door.	Platform truck-four wheel-hand. Start/Stop Fwd. <500#	93 11	volume 09 pg 210	Starts-with hands on handles ready to push. Includes-all the time necessary to push a hand truck,loaded or empty, for one foot. Ends-after moving hand cart for one foot.	Full <500# Ave. Dist=3' 11 tmu * 3'= 33 33 TMUs
Push empty general purpose cart to ultimate destination.	Platform truck-four wheel-hand. Start/Stop Fwd. <500#	93 11	volume 09 pg 210	Starts-with hands on handles ready to push. Includes-all the time necessary to push a hand truck,loaded or empty, for one foot. Ends-after moving hand cart for one foot.	Distance * 11 = varies ? TMUs
Maneuver empty general purpose cart to storage position.	Platform truck-four wheel-hand. Start/Stop Fwd. <500#	93 11	volume 09 pg 210	Starts-with hands on handles ready to push. Includes-all the time necessary to push a hand truck,loaded or empty, for one foot. Ends-after moving hand cart for one foot.	Full <500# Ave. Dist=5' 11 tmu * 5'= 55 55 TMUs

APPENDIX D

Standard Time Assignments for Operations Involving General Purpose Carts *DoD 5010.15.1-M

Vernacular Desc.	Operation/element Desc.	TMU's	Source*	Complete description	Est. TMU's
Grasp and push filled general purpose cart to material handling room.	Platform truck-four wheel-hand. Start/Stop Fwd. <500#	93 11	volume 09 pg 210	Starts-with hands on handles ready to push. Includes-all the time necessary to push a hand truck,loaded or empty, for one foot. Ends-after moving hand cart for one foot.	Distance * 11 = varies ? TMUs
Open door, allow the door to close automatically.	Door(passage), open & close quick release, pull to open with automatic closure.	127	volume 10 pg 64	Starts-with reach to knob. Includes-all motions necessary to release latch, pull door open,walk thru & release door. Ends-with release of door.	127 TMUs
Maneuver filled general purpose cart through door.	Platform truck-four wheel-hand. Start/Stop Fwd. <500#	93 11	volume 09 pg 210	Starts-with hands on handles ready to push. Includes-all the time necessary to push a hand truck,loaded or empty, for one foot. Ends-after moving hand cart for one foot.	Full <500# Ave. Dist=3' 11 tmu * 3'= 33 33 TMUs
Maneuver filled general purpose cart to sending spur. (General purpose cart must be positioned exactly)	Platform truck-four wheel-hand. Start/Stop Fwd. <500#	93 11	volume 09 pg 210	Starts-with hands on handles ready to push. Includes-all the time necessary to push a hand truck,loaded or empty, for one foot. Ends-after moving hand cart for one foot.	Full <500# Ave. Dist=5' 11 tmu * 5'= 55 55 TMUs
Walk to control panel.		5.2 TMUs per foot	Maynard 5-40		Distance varies Average = 7.67 ft. 7.67*5.2 + 40 TMUs

APPENDIX D

Standard Time Assignments for Operations Involving General Purpose Carts *DoD 5010.15.1-M

Vernacular Desc.	Operation/element Desc.	TMU's	Source*	Complete description	Est. TMU's
Select proper destination for interphase now on sending spur.	Switches, operate, control panel.	2 TMUs	volume 10 pg 03	Starts-with a reach to the switch. Includes-all intermediate reaches and swith activations. Ends-with a reaching away from the control panel to ready position.	2 TMUs

APPENDIX E

Measured Distances To/From Nearest Material Handling Room

BUILDING	FLOOR	Room No.	DEPARTMENT	DIST. TO MAT'L HANDLING ROOM	DIST. FROM MAT'L HANDLING ROOM
ANCILLARY	1	1C11E2	EMERGENCY ROOM	551	551
ANCILLARY	1	1C12D1	EMERGENCY ROOM	530	530
ANCILLARY	1	1C12E5	EMERGENCY ROOM	516	516
ANCILLARY	1	1C13E1	EMERGENCY ROOM	472	472
ANCILLARY	1	1C13E1	EMERGENCY ROOM	472	472
ANCILLARY	1	1C13H1	PRIMARY CARE	589	589
ANCILLARY	1	1C13H2	PRIMARY CARE	562	562
ANCILLARY	1	1C13H4	PRIMARY CARE	606	606
ANCILLARY	1	1D15D1	EMERGENCY ROOM	453	453
ANCILLARY	1	1D15D9	PRIMARY CARE	445	445
ANCILLARY	1	1E24E3	ORTHOPEDIC CLINIC	110	110
ANCILLARY	1	1E25E5	ORTHOPEDICS	139	139
ANCILLARY	1	1F27J2	ORTHOPEDIC CLINIC	92	92
ANCILLARY	2	2D16D3	DENTAL CLINIC	411	411
ANCILLARY	2	2D16F2	DENTAL CLINIC	335	335
ANCILLARY	2	2D16J2	ALLERGY	421	421
ANCILLARY	2	2D16J3	ALLERGY CLINIC	263	263
ANCILLARY	2	2E23G5	RADIOLOGY	106	188
ANCILLARY	2	2E23G6	RADIOLOGY	106	188
ANCILLARY	2	2E24E4	RADIOLOGY	141	222
ANCILLARY	2	2E24E5	RADIOLOGY	133	214
ANCILLARY	2	2G34E4	CARDIAC CATH LAB	308	310
ANCILLARY	2	2G34E5	RADIOLOGY	293	295
ANCILLARY	2	2G34F1	CARDIAC CATH LAB	278	277
ANCILLARY	2	2G34G1	CARDIAC CATH LAB	203	205
ANCILLARY	2	2H36H1	NUCLEAR MEDICINE	239	241
ANCILLARY	2	2J0102	OPHTHALMOLOGY	156	156
ANCILLARY	2	2K11P1	OTOLARYNGOLOGY	153	153
ANCILLARY	2	2L13T2	UROLOGY	164	164
ANCILLARY	3	3D18G1	DIALYSIS/NEPHROLOGY	251	251
ANCILLARY	3	3D18H1	DIALYSIS/NEPHROLOGY	251	251
ANCILLARY	3	3D18H2	DIALYSIS/NEPHROLOGY	251	251
ANCILLARY	3	3D19G1	DIALYSIS/NEPHROLOGY	291	291
ANCILLARY	3	3G31E2	LABOR AND DELIVERY	334	334
ANCILLARY	3	3G31J1	LABOR AND DELIVERY	221	221
ANCILLARY	3	3G32F3	LABOR AND DELIVERY	286	286
ANCILLARY	3	3G33D2	LABOR AND DELIVERY	355	397
ANCILLARY	3	3G33E2	LABOR AND DELIVERY	348	390
ANCILLARY	3	3G34E1	NURSERY/NICU	331	373
ANCILLARY	3	3G35G1	NURSERY/NICU	290	198
ANCILLARY	3	3G35G5	NURSERY/NICU	226	134
ANCILLARY	3	3G36F1	NURSERY/NICU	290	196
ANCILLARY	3	3G36H1	NURSERY/NICU	226	134

APPENDIX E

Measured Distances To/From Nearest Material Handling Room

BUILDING	FLOOR	Room No.	DEPARTMENT	DIST. TO MAT'L HANDLING ROOM	DIST. FROM MAT'L HANDLING ROOM
ANCILLARY	3	3H35G4	NURSERY	319	225
ANCILLARY	4	4D20G1	MAIN OPERATING ROOM	176	176
ANCILLARY	4	4E22H1	MAIN OPERATING ROOM	146	146
ANCILLARY	4	4E23J1	MAIN OPERATING ROOM	93	93
ANCILLARY	4	4E23J2	MAIN OPERATING ROOM	93	93
ANCILLARY	4	4E25G1	PACU	203	203
ANCILLARY	4	4E25H4	PACU	203	203
ANCILLARY	4	4E25H6	PACU	179	179
ANCILLARY	4	4E25H7	PACU	192	192
ANCILLARY	4	4E25H8	PACU	192	192
ANCILLARY	4	4F26H2	PACU	175	175
ANCILLARY	4	4G31E1	ICU #1	397	440
ANCILLARY	4	4G32D1	INTENSIVE CARE NRSY	421	464
ANCILLARY	4	4G33E1	ICU #2	397	440
ANCILLARY	4	4G33E2	ICU #2	397	440
ANCILLARY	4	4G33G5	ICU #2	333	281
ANCILLARY	4	4G33J2	RESPIRATORY THERAPY	193	234
ANCILLARY	4	4G34G4	ICU #2	292	240
ANCILLARY	4	4H35G1	CORONARY CARE NRSY	295	243
ANCILLARY	4	4H35G3	CCU	258	206
ANCILLARY	4	4H36G4	CCU	279	227
ANCILLARY	4	4H36H1	CCU	243	191
EAST TOWER	2	2RR151	NURSING WARD	186	233
EAST TOWER	2	2RR172	NURSING WARD	145	192
EAST TOWER	2	2RR241	NURSING WARD	221	236
EAST TOWER	3	3RR173	NURSING WARD	164	228
EAST TOWER	3	3RR173	NURSING WARD	164	228
EAST TOWER	3	3RR174	NURSING WARD	164	228
EAST TOWER	3	3RR176	NURSING WARD	164	228
EAST TOWER	4	4RR173	NURSING WARD	164	228
EAST TOWER	4	4RR174	NURSING WARD	164	228
EAST TOWER	4	4RR176	NURSING WARD	164	228
EAST TOWER	5	5RR173	NURSING WARD	164	228
EAST TOWER	5	5RR174	NURSING WARD	164	228
EAST TOWER	5	5RR176	NURSING WARD	164	228
NORTH CLINIC	1	1L16S5	OB/GYN	89	89
NORTH CLINIC	1	1L16S6	OB/GYN CLINIC	99	99
NORTH CLINIC	1	1M21R1	REHAB MEDICINE	100	100
NORTH CLINIC	1	1M22S2	REHAB MEDICINE	157	157
NORTH CLINIC	1	1M22V4	REHAB MEDICINE	244	244
NORTH CLINIC	1	1M23R2	REHAB MEDICINE	177	177
NORTH CLINIC	1	1M23S1	REHAB MEDICINE	143	143
NORTH CLINIC	2	2L14S3	UROLOGY	111	111

APPENDIX E

Measured Distances To/From Nearest Material Handling Room

BUILDING	FLOOR	Room No.	DEPARTMENT	DIST. TO MAT'L HANDLING ROOM	DIST. FROM MAT'L HANDLING ROOM
NORTH CLINIC	2	2L14T1	UROLOGY CLINIC	144	144
NORTH CLINIC	2	2L15S1	UROLOGY	111	111
NORTH CLINIC	2	2L15T3	UROLOGY	93	93
NORTH CLINIC	2	2L16S1	UROLOGY	111	111
NORTH CLINIC	2	2L16S2	UROLOGY	111	111
NORTH CLINIC	2	2L17S4	NEUROSURGERY	28	28
NORTH CLINIC	2	2L17U4	ENDOCRINOLOGY	98	98
NORTH CLINIC	2	2M20R2	NEUROLOGY	84	84
NORTH CLINIC	2	2M20R3	NEUROLOGY/NEUROSURG.	74	74
NORTH CLINIC	2	2M21V1	HEMATOLOGY/ONCOLOGY	218	218
NORTH CLINIC	2	2M22S2	HEMATOLOGY/ONCOLOGY	152	152
NORTH CLINIC	2	2M23S1	RHEUMATOLOGY	157	157
NORTH CLINIC	3	3L13T2	INTERNAL MEDICINE	160	160
NORTH CLINIC	3	3L14T1	INTERNAL MEDICINE CL	140	140
NORTH CLINIC	3	3L17V4	PULMONARY CLINIC	129	129
NORTH CLINIC	3	3L17W1	PULMONARY CLINIC	158	158
NORTH CLINIC	3	3M22S2	CARDIOLOGY	152	152
NORTH CLINIC	3	3M23S1	CARDIOLOGY	157	157
NORTH CLINIC	4	4L13T2	SURGERY CLINIC	161	161
NORTH CLINIC	4	4L14T1	SURGERY CLINIC	144	144
NORTH CLINIC	4	4L15S2	SURGERY CLINIC	128	128
NORTH CLINIC	4	4L15S3	SURGERY CLINIC	137	137
NORTH CLINIC	4	4L16S1	SURGERY CLINIC	134	134
NORTH CLINIC	4	4L16S2	SURGERY CLINIC	71	71
NORTH TOWER	1	1QQ101	OPEN PSYCHIATRY	132	133
NORTH TOWER	2	2QQ173	NURSING WARD	132	129
NORTH TOWER	2	2QQ174	NURSING WARD	132	129
NORTH TOWER	2	2QQ174	NURSING WARD	132	129
NORTH TOWER	2	2QQ176	NURSING WARD	132	129
NORTH TOWER	3	3QQ173	NURSING WARD	132	129
NORTH TOWER	3	3QQ174	NURSING WARD	132	129
NORTH TOWER	3	3QQ176	NURSING WARD	132	129
NORTH TOWER	4	4QQ173	NURSING WARD	132	129
NORTH TOWER	4	4QQ174	NURSING WARD	132	129
NORTH TOWER	4	4QQ176	NURSING WARD	132	129
NORTH TOWER	5	5QQ173	NURSING WARD	132	129
NORTH TOWER	5	5QQ174	NURSING WARD	132	129
NORTH TOWER	5	5QQ176	NURSING WARD	132	129
SOUTH CLINIC	1	1J02R2	OCC.MED./STAFF S/C	247	247
SOUTH CLINIC	1	1J0505	CHILD CARE NURSERY	99	99
SOUTH CLINIC	1	1K07P1	PEDIATRICS	57	57
SOUTH CLINIC	1	1K0901	PEDIATRIC CLINIC	100	100
SOUTH CLINIC	1	1K09S3	PEDIATRIC CLINIC	213	213

APPENDIX E

Measured Distances To/From Nearest Material Handling Room

BUILDING	FLOOR	Room No.	DEPARTMENT	DIST. TO MAT'L HANDLING ROOM	DIST. FROM MAT'L HANDLING ROOM
SOUTH CLINIC	1	1K10P1	PEDIATRICS	132	132
SOUTH CLINIC	1	1K1103	PEDIATRIC CLINIC	186	186
SOUTH CLINIC	1	1K11R4	PEDIATRIC CLINIC	251	251
SOUTH CLINIC	1	1K11R5	PEDIATRICS	251	251
SOUTH CLINIC	2	2J0201	OPHTHALMOLOGY	144	144
SOUTH CLINIC	2	2J03N2	OPHTHALMOLOGY	106	106
SOUTH CLINIC	2	2J03N2	OPHTHALMOLOGY	106	106
SOUTH CLINIC	2	2K07P6	PLASTIC SURGERY	68	68
SOUTH CLINIC	2	2K07Q2	PLASTIC SURGERY	89	89
SOUTH CLINIC	2	2K10P2	ENT	148	148
SOUTH CLINIC	3	3K0703	GASTROENTEROLOGY	32	32
SOUTH CLINIC	3	3K0901	GASTROENTEROLOGY	84	84
SOUTH CLINIC	3	3K0903	GASTROENTEROLOGY	106	106
SOUTH CLINIC	3	3K1006	GASTROENTEROLOGY	141	141
SOUTH CLINIC	3	3K10P3	DERMATOLOGY	188	188
SOUTH CLINIC	3	3K10R3	DERMATOLOGY	209	209
SOUTH CLINIC	3	3K11Q5	DERMATOLOGY	292	292
SOUTH CLINIC	3	3K11R5	DERMATOLOGY	320	320
SOUTH CLINIC	3	3K11S1	DERMATOLOGY	328	328
WEST TOWER	1	1PP021	CLOSED PSYCHIATRY	134	53
WEST TOWER	1	1PP241	NURSING WARD	188	188
WEST TOWER	2	2PP173	NURSING WARD	241	148
WEST TOWER	2	2PP174	NURSING WARD	241	148
WEST TOWER	2	2PP176	NURSING WARD	241	148
WEST TOWER	3	3PP173	NURSING WARD	241	148
WEST TOWER	3	3PP174	NURSING WARD	241	148
WEST TOWER	3	3PP176	NURSING WARD	241	148
WEST TOWER	4	4PP173	NURSING WARD	241	148
WEST TOWER	4	4PP174	NURSING WARD	241	148
WEST TOWER	4	4PP176	NURSING WARD	241	148
WEST TOWER	5	5PP173	NURSING WARD	241	148
WEST TOWER	5	5PP174	NURSING WARD	241	148
WEST TOWER	5	5PP176	NURSING WARD	241	148

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